Development of Innovative Techniques for Producing Line-of-sight Corrected Synoptic Maps with an Application for a UVCS Outflow Velocity Database

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1. Introduction

The primary goal of this project is to produce a set of outflow velocity maps for the extended corona which cover all phases of Solar Cycle 23. Such maps do not currently exist and the limited regions which have been studied with synoptic data have been used to produce outflow velocities that are averaged over the line-of-sight. For this project, we use a database of more than 10 years of synoptic data obtained with the Ultraviolet Coronagraph Spectrometer (UVCS) on the Solar and Heliospheric Observatory (SOHO).

The specific objectives that need to be accomplished for this project are the following: 1) to develop the software tools for computing "localized" coronal plasma parameters (kinetic temperatures and outflow speeds) for hydrogen and oxygen ions in the solar corona, 2) to produce a database of synoptic data for UV line intensities and empirically derived plasma parameters for different coronal structures within the solar wind acceleration region (2-4 R_o) of the extended corona, and 3) to develop a user-friendly interface for data selection and visualization of the coronal UV line intensities and empirical plasma parameters.

In addition to the PI, the project team includes CoIs Alexander Panasyuk and John Kohl (SAO) and Nick Arge, a collaborator from the Air Force Research Laboratory, Hanscom AFB.

2. Activities and accomplishments in the last year

During the first year of funding we have made progress on each of the three primary objectives mentioned above. Since the actual number of work hours that was used is significantly less than what was planned for the first year, we are somewhat behind the original proposed schedule. However it is expected that the completion of another outside project during the upcoming year will free up significant time so that we should be able to catch up to the original schedule during the second year of performance.

The status of the four subtasks which were proposed for Year 1 in the proposal is discussed below:

1) *Development of preprocessing software for the UVCS data arrays*. We have incorporated new features in the UVCS preprocessing package which includes using separate radiometric calibration factors for each year of the data (1996-2006). A program module for selecting and displaying individual synoptic maps with overlay latitude-longitude grids has also been created. Another existing software module has been modified to produce high resolution maps with 2 deg latitudinal resolution, as opposed to the original 6 deg binning. Currently, the data extraction program produces line-of-sight integrated quantities (intensities and line widths) for the bright spectral lines of H I 1261.6 nm, OVI 103.2 nm and OVI 103.7 nm. The range of heights included in the data base is from 1.3 to 3.3 solar radii from sun center. The high resolution data will be used for extracting information on detailed structures which are most relevant for solar wind studies in the ecliptic plane. The 3D reconstruction software is described under item 2 below.

2*) Development of software for making 3D reconstructions.* The code for producing 3D reconstructions has been tested with all three spectral line intensities and works fairly well for

the solar minimum corona. It will require some fine tuning in order for it to be used for periods when the corona changes rapidly compared to the time for large scale features to rotate around the limb.

3) *Development of software for producing outflow velocities from OVI ratios.* Existing Fortran codes (Strachan et al., 2000) are used to convert the OVI 103.2 /103.7 intensity ratios into oxygen outflow velocities. After some new modifications based on the work by Noci & Gavryuseva (2007), we are ready to convert the Fortran codes into IDL for compatibility with the other software modules.

4) *Development of software for producing electron densities from OVI ratios.* In the past, electron densities derived from white light coronagraph data (e.g. SOHO/LASCO) were used as a basis for the determining the outflow velocity. However by using the technique proposed by Noci & Gavryuseva (2007), it may be possible to obtain outflow velocities without any assumption on the electron density. If this can be verified with our work, we will no longer need to produce these quantities. In some cases, the electron density may still be required and we will obtain this quantity from the OVI 103.2/103.7 line ratios.

Some of the work that was originally scheduled for the second year has already been started. This is the work for the visualization tool. We have chosen to use the Vis5d+ software package to display the 2D and 3D data representations for the velocities and temperatures that will be produced from this work. See Figure 1 for a sample image produced from this software package.

3. Future work

By the end of the second year we will have completed the software for producing the "localized" intensities. The experience gained from this will be used to test for the feasibility of providing "localized" values for the line widths. The Vis5d+ visualization tool will be fully implemented and tested with potential users (N. Arge and others). The plan for the second year also includes developing a Web-based data retrieval tool so that users can easily selected specific time periods from the database.

4. References.

Noci, G., & Gavryuseva, E. 2007, *Astrophysical Journal*, 658, L63.

Strachan, L., et al. 2000, *J. Geophys. Research,* 105, 2345.

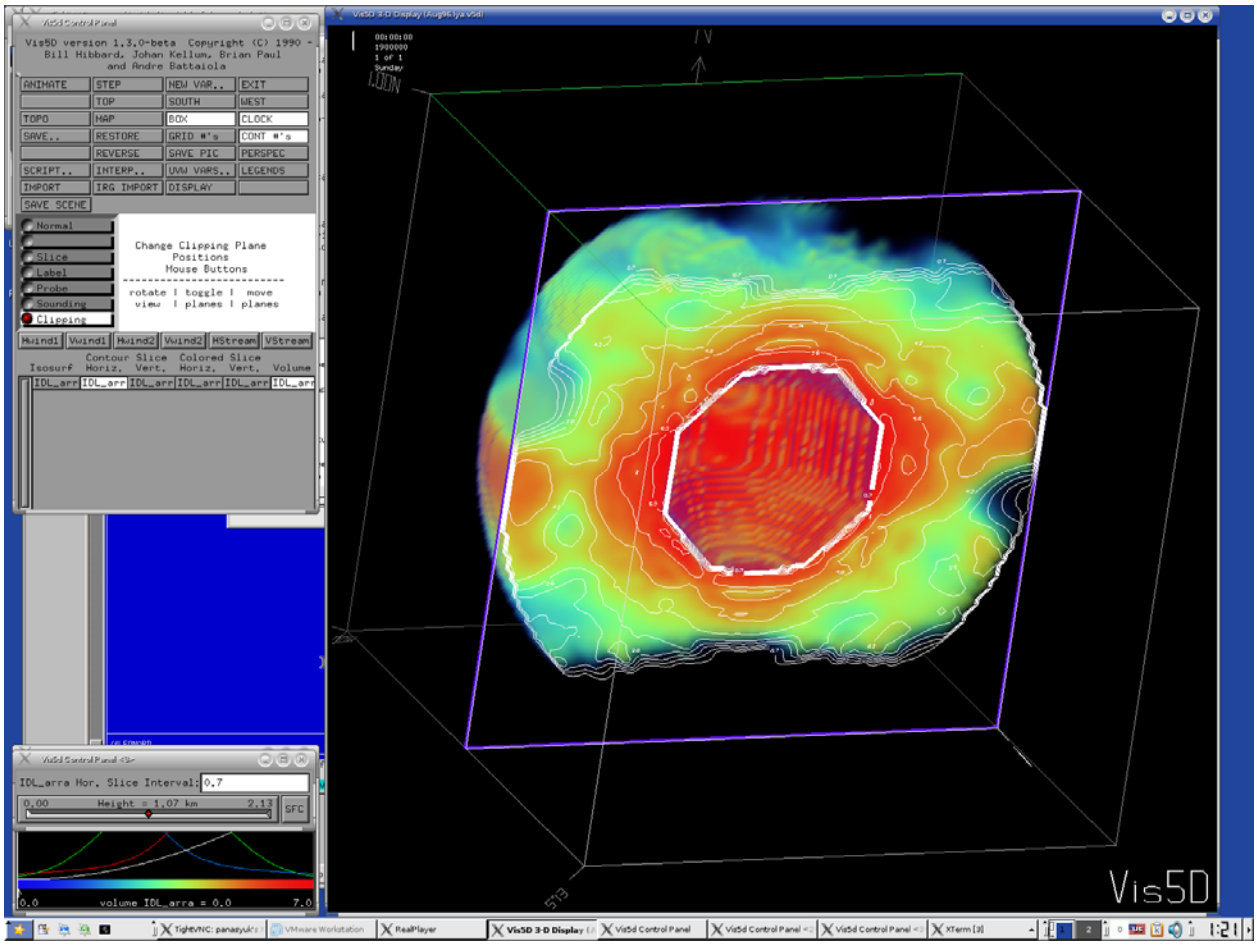

Figure 1: A cut through a 3-D reconstruction of the coronal intensity distribution of H-Lyman alpha. Lyman alpha is the brightest emission line in the solar corona and it is used (along with other quantities) to model the outflow velocities in the extended solar corona. The display was created with the Vis5d+ software tool. With Vis5d+, the coronal model can be rotated and different cuts through the data can be displayed.